Estimating Reductions in Nutrients and Sediments from PA Regulated Stormwater

Analysis Conducted by Chesapeake Bay Program Modeling Team including:

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Background

In response to a request by the Pennsylvania Department of Environmental Protection (PADEP), the Chesapeake Bay Program Modeling Team ran a series of scenarios to estimate reductions in nutrients delivered to the Chesapeake Bay in an average year that could result from targeting 10%, 15% and 20% reductions in sediment from MS4 regulated, urban areas.

Methods

The Modeling Team ran three scenarios in order to develop a relationship between delivered sediment and nutrient reductions from PA's MS4 regulated, urban areas. Each scenario assumed that these communities would utilize best management practices to treat 2.8 inches of stormwater from each acre of land treated. Using the 2.8 inch goal, the Modeling Team estimated both the number of acres of impervious and pervious MS4 land and the total volume of water that would require treatment to achieve estimated delivered sediment reductions of 10%, 15% or 20%. All scenarios were compared to the Bay Program's official 2014 Progress scenario results so the reductions could be described as the result of additional actions in the future with the assumption that current actions practices remained in place. The results from these three scenarios were then used to develop linear regressions which described the relationship between delivered sediment and nutrient reductions.

Total Treatment Required

The Modeling Team attempted to estimate the number of acres of MS4 land and volume of water that would require treatment within PA's portion of the Chesapeake Bay Watershed to achieve the targeted reductions in delivered sediment. This can be calculated statewide if it is assumed that 1) every project will treat to the PA-required 2.8 inch performance standard[1], and 2) every project contains the same mixture of impervious and pervious acres. For 2014, that mixture was 132,209 impervious acres and 414,043 pervious acres, or 3.13 pervious, regulated acres for every 1 impervious, regulated acre. This ratio was assumed to remain constant in each scenario. The Modeling Team also estimated the volume of stormwater (in acre-feet) that would require treatment. These estimates are presented in Table 1. As you can see, treating to the very high 2.8 inch performance standard means that only a portion of the total regulated acres and stormwater volume require treatment to achieve the estimated reductions. In reality, reductions are based on site-specific parameters, with one site potentially treating mainly

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[1] Performance standard reductions are based upon removal rate adjustor curves described in the expert panel report which can be found at: http://www.chesapeakebay.net/documents/Final-CBP-Approved-Expert-Panel-Report-on-Stormwater-Performance-Standards-LONG_012015.pdf. It was assumed that all practices implemented in these scenarios would be stormwater treatement (ST) practices, and thus use the ST curves described in this document to estimate reductions.

impervious acres to a 3 inch standard while another treats mainly pervious to a 1.2 inch standard. Those site-specific mixtures could not be considered for these statewide planning scenarios.

Table 1. Necessary Acres and Volume Treated to Achieve Targeted Percent Reductions in Delivered Sediment

Percent Reduction in Delivered Sediment (Goal)	Total Acres (2014 Progress)	Total Acres Treated	Impervious Acres (2014 Progress)	Impervious Acres Treated	Pervious Acres (2014 Progress)	Pervious Acres Treated	Volume (Acre-Feet)
20%	546,252	137,496	132,209	33,292	414,043	104,204	7,769
15%	546,252	102,411	132,209	24,797	414,043	77,614	5,786
10%	546,252	68,748	132,209	16,646	414,043	52,102	3,885

Results

This analysis indicated that the Phase 5.3.2 Watershed Model's estimates of nutrients reduced from stormwater performance standard projects are directly related to sediment reductions from those projects. Figure 1 shows the percent reductions that were found in each of the three scenarios as well as the relationship between these reductions. The relationships of sediment reductions to phosphorus and nitrogen reductions are described in the equations in Figure 1. These relationships allow PA to estimate the statewide reductions in nutrients that could result from any targeted sediment reduction from MS4 lands. Table 2 includes potential reductions for a number of sediment targets based upon these relationships.

Figure 1. Relationship of Phase 5.3.2 Watershed Model Reductions of Delivered TSS and Nutrients
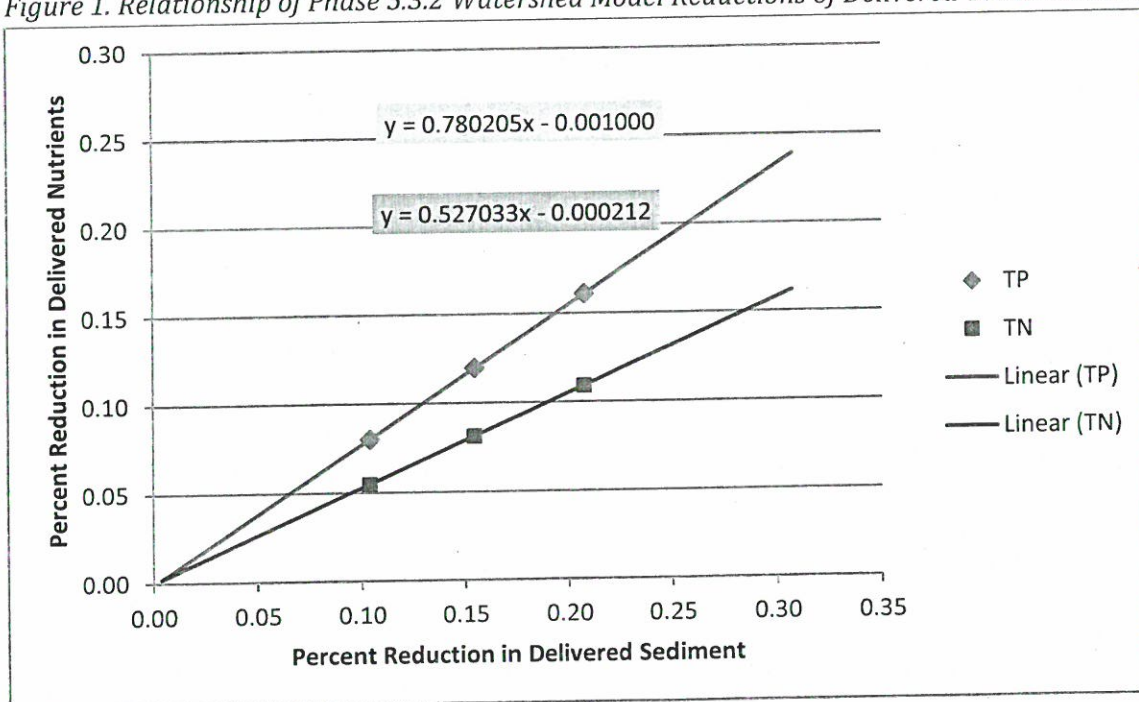

$$y = 0.780205x - 0.001000$$

$$y = 0.527033x - 0.000212$$

Table 2. Estimated Phase 5.3.2 Watershed Model Reductions of Delivered Nutrients Based Upon Sediment Reduction Target

Percent Reduction in Delivered Sediment	Percent Reduction in Delivered Phosphorus	Percent Reduction in Delivered Nitrogen
5%	3.8%	2.6%
8%	5.8%	3.9%
10%	7.7%	5.2%
12.50%	9.7%	6.6%
15%	11.6%	7.9%
17.50%	13.6%	9.2%
20%	15.5%	10.5%
22.50%	17.5%	11.8%
25%	19.4%	13.2%
27.50%	21.4%	14.5%
30%	23.3%	15.8%

This analysis dealt only with the estimated nutrient and sediment loads from MS4 regulated areas. In 2014 Progress, MS4 regulated impervious and pervious lands accounted for 6.7% of all nitrogen, 4.2% of all phosphorus and 4.8% of all sediment from PA's portion of the Chesapeake Bay Watershed. While reductions from these lands are important for local water quality and the Chesapeake Bay, Table 3 shows that much greater reductions are needed across other PA sectors in order to achieve the targets described in PA's Phase II Watershed Implementation Plans. Additionally, these scenarios assume zero increase in regulated acres. Any increase in acres due to development will require further treatment and retrofitting of existing acres in order to offset the new load.

Table 3. Phase 5.3.2 Estimated Delivered Nutrients and Sediment Compared to 2025 Phase II WIP Targets

Delivered Nutrient	2014 Progress	10% Sediment Reduction	15% Sediment Reduction	20% Sediment Reduction	2025 Target
TN (Lbs)	117,013,836	116,583,127	116,372,094	116,152,083	78,995,996
TP (Lbs)	4,438,258	4,422,675	4,415,002	4,406,998	3,570,897
TSS (Tons)	1,309,035	1,302,014	1,298,588	1,295,015	972,616

Additional results can be downloaded from http://baytas.chesapeakebay.net/ upon request. Please visit the site and request a username and password to view all official scenarios. Once you have obtained a username and password, please contact Matt Johnston at mjohnston@chesapeakebay.net to request access to these scenarios.